

## **Kagan Tumer**

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### **EDUCATION:**

#### **The University of Texas, Austin, Texas**

Ph.D. in Electrical and Computer Engineering, May 1996.

Dissertation title: *Linear and Order Statistics Combiners for Reliable Pattern Recognition*

M.S.E. in Electrical and Computer Engineering, August, 1992.

Thesis title: *Structural Adaptation and Generalization in Neural Networks*

#### **George Mason University, Fairfax, Virginia**

B.S. in Electrical Engineering, with distinction, May, 1989.

### **RESEARCH INTERESTS:**

Control of Collectives, design of complex systems, complexity measures, inverse game theory.  
Statistical inferencing, classifier ensembles, classification in unbalanced data sets.

### **WORK EXPERIENCE:**

**NASA Ames Research Center**, Moffett Field, CA. July 1997 to present  
Research Scientist; Computational Sciences Division.  
(July 1997 to September 1999: Caelum Research Corp.)

**The University of Texas**, San Antonio, TX. September 1996 to June 1997  
Visiting Assistant Professor; Division of Engineering.

**The University of Texas**, Austin, TX. September 92 to May 1996  
Teaching/Research Assistant; Department of Electrical and Computer Engineering.

**Tracor Inc.**, Austin, TX. June 1992 to August 1992  
Engineer; Research and Development.

**Halliburton Logging Service**, Austin, TX. November 1989 to September 1991  
Engineer; Austin Research Center.

**George Mason University**, Fairfax, VA. September 1986 to May 1989  
Tutor (Mathematics and French); University Tutorial Services.

### **TEACHING EXPERIENCE:**

Visiting Assistant Professor at The University of Texas, San Antonio:

Electrical Circuits (Fall 96; Spring 97).  
Signals and Systems (Fall 96; Spring 97).  
Information Theory and Coding (Fall 96).  
Neural Networks for Pattern Recognition (Spring 97, graduate level).

Guest Lecturer at The University of Texas, Austin:

Advanced Topics in Neural Networks (Spring 96, 2 lectures).  
Computer Vision (Spring 96, 2 lectures).

## **FUNDED PROPOSALS:**

- “Self-Dissimilarity: An empirical measure of complexity,” *Director’s Discretionary Funding*, NASA Ames Research Center. Co-Is: David Wolpert, Kagan Tumer, NASA Ames Research Center. \$40,000 per year for two years starting 2002.
- “Artificial Collective Intelligence” *Intelligent Systems* Program, directed funding. Co-Is: David Wolpert, Kagan Tumer, NASA Ames Research Center. \$315,000 per year starting 2002.
- “Artificial Collective Intelligence” NASA Research Announcement for *Thinking Systems* (NRA-632). Co-Is: David Wolpert, Kagan Tumer, NASA Ames Research Center. \$320,000 per year for three years starting 1999.
- “Science Directed Autonomy for Astrobiology Missions”, NASA research announcement for *thinking systems* (NRA-632), for fiscal year 1999. Co-Is: Paul Stolorz, Frank Carsey, Eric Mjolness, JPL; Kagan Tumer, David Wolpert, NASA Ames Research Center. \$390,000.
- “Fundamental Properties of Autocatalytic Systems”, NASA Research announcement on Computational Astrobiology 2000. Co-Is: Michael New, Kagan Tumer, Charles Blakwell, NASA Ames Research Center. \$60,000 per year for three years, starting 2000.

## **PROGRAM/GRANT MANAGEMENT:**

### **Research Program:**

- “System Complexity Research.” Part of the *Engineering and Complex Systems* Program. Budget: \$150,000 per year for five years to stimulate research in complexity measures.

### **Grants Awarded:**

- “Mechanism Design for a Complex System.” PI: David Parkes, Harvard University. \$40,000, June 2001.
- “Robustness of Networked Agents.” PI: John Doyle, Caltech. \$40,000, May 2001.
- “Collective Control for Aeronautical Systems.” PI: Ilan Kroo, Stanford University. \$75,000, April 2002.
- “Design and Control of Large Collections of Learning Agents.” PI: Joydeep Ghosh, The University of Texas. \$32,000, January 2002.

## **PATENT:**

- “Spectroscopic detection of cervical pre-cancer using radial basis function networks”. US patent no. 6,135,965 (Oct. 2000). Inventors: K. Tumer, N. Ramanujam, J. Ghosh and R. Richards-Kortum.

## **TECHNICAL ACTIVITIES:**

### **Workshop/Symposium Organization:**

- Co-Chair of the “Collectives and the Design of Complex Systems” workshop at *NASA Ames Research Center*, Moffett Field, CA, August 2002.
- Co-Chair of the “Distributed Learning for Optimization” special session in the *Congress on Evolutionary Computation (CEC)*, Honolulu, HI, May 2002.
- Co-Chair of the “Collaborative Learning Agents” Symposium at *AAAI Spring symposium*, Stanford, CA, March 2002.
- Co-Chair of the “Behavior of Collectives: Mathematical Foundations of Distributed Intelligence” workshop at *the Santa Fe Institute*, Santa Fe, NM, January 2002.
- Co-Chair of the “Turnkey Algorithms for Improving Generalizers” workshop at *NIPS 1998*, Denver, CO, December 1998.

### **Conference/Workshop Program Committees:**

- Artificial Neural Networks in Engineering (ANNIE 2002)*, St. Louis, MO, November 2002.

*Multiple Classifier Systems (MCS 2002)*, Sardinia, Italy, June 2002.  
*International Joint Conference on Neural Networks (IJCNN 2002)*, Honolulu, HI, June 2002.  
*Artificial Neural Networks in Engineering (ANNIE 2001)*, St. Louis, MO, November 2001.  
*Multiple Classifier Systems (MCS 2001)*, Cambridge, UK, June 2001.  
*Learning Agents* workshop at *Autonomous Agents 2001*, Montreal, CA, May 2001.  
*Distributed and Parallel Knowledge Discovery* workshop at KDD-2000, Boston, MA, August 2000.  
*Artificial Neural Networks in Engineering (ANNIE 2000)*, St. Louis, MO, November 2000.  
*Artificial Neural Networks in Engineering (ANNIE 1999)*, St. Louis, MO, November 1999.

#### **Reviewer for Following Journals/Conferences:**

IEEE Transactions on Pattern Analysis and Machine Learning (IEEE)  
 IEEE Transactions on Computers (IEEE)  
 Machine Learning (Kluwer)  
 IEEE Transactions on Neural Networks (IEEE)  
 IEEE Transactions on Knowledge and Data Engineering (IEEE)  
 Medical and Biological Engineering and Computation  
 Pattern Analysis and Applications (Springer)  
 Pattern Recognition (Elsevier)  
 International Journal of Smart Engineering System Design (Gordon and Breach)

Autonomous Agents  
 Multiple Classifier Systems  
 Artificial Neural Networks in Engineering  
 International Joint Conference on Neural Networks  
 International Conference on Discovery and Data Mining  
 Australian Conference on Neural Networks  
 International Conference on Document Analysis and Recognition

#### **Reviewer/Referee for Following Awards/Proposals:**

“Director’s Discretionary Funding” proposals. (Select 10 out of 35-50 cross-disciplinary proposals to promote innovative, high risk research). February 2000, August 2000, February 2001, August 2001, February 2002.  
 “H. Julian Allen award” (Best paper by a NASA Ames scientist). 2000, 2001, 2002.  
 “Associate Ames Fellow award” (Recognize body of work by an Ames scientist). 2000, 2001, 2002.  
 “RIACS Summer Student Research Program” (Select 10 students a year out of 60-80 applicants for summer research positions in Computational Sciences Division). 2000, 2001, 2002.  
 “Graduate Student Research Program” (Select 6 students a year out of over 30 applicants to work at NASA Ames Research Center). 2000, 2001, 2002.  
 “Best Application Paper”, *ANNIE 1999*, St. Louis, MO, November 1999.  
 “Best Theoretical Paper”, *ANNIE 1998*, St. Louis, MO, November 1998.

#### **Educational Activities:**

Dissertation committee of Adrian Agogino, Electrical and Computer Engineering Dept., The University of Texas at Austin (Expected Defense: Spring 2003).  
 Graduate Council Member, The University of Texas at San Antonio. (Served on Thesis committee for Master’s student; Designed new graduate level course.)  
*Engineering Week*: Visit local schools as part of a NASA program and present space sciences to 4th and 5th graders, March 1998, Sunnyvale, CA.  
*Discover Engineering*: Panelist in a live NTU broadcast to answer questions from high school students interested in engineering, February 1997, Lisle, IL.

**Miscellaneous:**

Member, Ames Basic Research Council, Feb 2000-Present.  
 Session Chair (Multiple Classifier Systems), *MCS 2001*, Cambridge, UK, July 2001.  
 Session Chair (Multi-Agent Systems), *ICML 2000*, Stanford, CA, July 2000.  
 Session Chair (Learning Algorithms), *ANNIE 1998*, St. Louis, MO, November 1998.  
 Session Chair (System Model Identification), *IJCNN 1998*, Anchorage, AL, May 1998.  
 Student Organizer, *SPIE 1995*, Orlando, FL, April 1995.

**Professional and Honor Society Affiliations:**

Member of *The Institute of Electrical and Electronics Engineers*.  
 Member of *American Association of Artificial Intelligence*.  
 Member of *The IEEE Computer Society*.  
 Member of *Eta Kappa Nu Electrical Engineering Honor Society* (1988).  
 Member of *Alpha Chi National Honor Society* (1987).

**INVITED PRESENTATIONS:**

- “Introduction to Collective Intelligence,” Workshop on Distributed Intelligence - Mathematical Foundations of Collectives, Santa Fe Institute, NM, January 25, 2002.
- “Collective Intelligence: Design of Large Distributed Systems,” Computer Science Colloquium, Computer Science Dept., Sonoma State University, CA, November 15, 2001.
- “Distributed Control and Optimization with Collective Intelligence,” AI Seminar, Electrical Engineering and Computer Science Dept., UC Berkeley, CA, March, 2001.
- “Collective Intelligence: Designing Reward Functions in Distributed Reinforcement Learning,” ICML Workshop on “Multi-Agent Learning,” Stanford, CA, July, 2000.
- “Optimal Reward Functions in Distributed Reinforcement Learning” RIACS Seminar, NASA Ames Research Center, May 11, 2000.
- “Collective Intelligence” (3 hrs), ANNIE 1999 tutorial, St. Louis, MO, November 7, 1999.
- “Classifier Ensemble: How and Why they Work” (3 hrs), ANNIE 1999 tutorial, St. Louis, MO, November 7, 1999.
- “An Introduction to Collective Intelligence”, Learning Seminar, Stanford University, September 30, 1999.
- “Collective Intelligence, Part 2: Application to Internet Traffic Routing”, Computational Sciences Division, NASA Ames Research Center, May 18, 1999.
- “Collective Intelligence, Part 1: An Introduction”, Autonomy Seminar, NASA Ames Research Center, May 13, 1999.
- “Collective Intelligence”, Laboratory for Artificial Neural Systems, The University of Texas, Austin, April, 1997.
- “Classifier Combining: Analytical Results and implications”, AAAI Workshop on “Integrating Multiple Learning Models,” Portland, OR, August 1996.

**PUBLICATIONS:****Archival Journal Articles:**

1. Kagan Tumer and Adrian Agogino, “Time-Extended Payoffs for Collectives of Autonomous Agents”. Submitted.

2. Kagan Tumer and Nikunj Oza, "Input Decimated Ensembles". *Pattern Analysis and Applications*. Accepted.
3. Kagan Tumer and Joydeep Ghosh, "Bayes Error Rate Estimation using Neural Network Ensembles." Submitted.
4. David Wolpert and Kagan Tumer, "Collective Intelligence, Data Routing and Braess' Paradox," *Journal of Artificial Intelligence Research*. Volume 16, pp 359-387, June 2002.
5. Kagan Tumer and Joydeep Ghosh, "Robust Combining of Disparate Classifiers through Order Statistics," *Pattern Analysis and Applications, Special Issue on Fusion of Multiple Classifiers*. Volume 5, Number 2, pp 189-200, 2002.
6. David Wolpert and Kagan Tumer, "Optimal Payoff Functions for Members of Collectives," *Advances in Complex Systems*, Vol. 4, Nos. 2 & 3, pp. 265-279, October 2001.
7. David Wolpert, Kevin Wheeler and Kagan Tumer, "Collective Intelligence for Distributed Control," *Europhysics Letters*, Vol. 49, No. 6, March 2000.
8. Kagan Tumer, Nirmala Ramanujam, Joydeep Ghosh and Rebecca Richards-Kortum "Ensembles of Radial Basis Function Networks for Spectroscopic Detection of Cervical Pre-Cancer," *IEEE Transactions on Biomedical Engineering*, Vol. 45, No. 8, pp 953-961, August 1998.
9. Kagan Tumer and Joydeep Ghosh, "Error Correlation and Error Reduction in Ensemble Classifiers," *Connection Science, Special Issue on Combining Artificial Neural Networks: Ensemble Approaches*, Volume 8, Numbers 3 & 4, pp 385-404, December 1996.
10. Kagan Tumer and Joydeep Ghosh, "Analysis of Decision Boundaries in Linearly Combined Neural Classifiers," *Pattern Recognition*, pp 341-348, Vol. 29, No. 2, February 1996.
11. José Nelson Amaral, Kagan Tumer and Joydeep Ghosh, "Designing Genetic Algorithms for the State Assignment Problem," *IEEE Transactions on Systems, Man and Cybernetics*, pp. 687-695, Vol. 25, No. 4, April 1995.
12. Joydeep Ghosh and Kagan Tumer, "Structural Adaptation and Generalization in Supervised Feed-Forward Networks," *Journal of Artificial Neural Networks*, pp. 431-458, Vol. 1, No. 4, 1994.

#### **Books:**

1. J. Crutchfield, C. Shalizi, K. Tumer and D. Wolpert, Editors. *Collective Cognition: Mathematical Foundations of Distributed Intelligence*, Oxford University Press (SFI Studies in the Sciences of Complexity series). To appear.
2. K. Tumer and D. Wolpert, Editors. *Collectives and the Design of Complex Systems*, Springer. To appear.

#### **Book Chapters:**

1. Kagan Tumer and David Wolpert, "An Introduction to Collectives," K. Tumer and D. Wolpert, Editors *Collectives and the Design of Complex Systems*, Springer. (To appear.)
2. David Wolpert and Kagan Tumer, "Optimal Payoff Functions for Members of Collectives," F. Schweitzer, Editor, *Modeling Complexity in Economic and Social Systems*, World Scientific, Volume 4, no. 2/3, pp 265-279, 2002.
3. Kagan Tumer and Joydeep Ghosh, "Robust Order Statistics based Ensembles for Distributed Data Mining," H. Kargupta and P. Chan, Editors, *Advances in Distributed and Parallel Knowledge Discovery*, pp. 185-210, AAAI/MIT Press, 2000.

4. David Wolpert and Kagan Tumer, "A Survey of Collective Intelligence," Jeffrey M. Bradshaw, Editor, *Handbook of Agent Technology*, AAAI Press/MIT Press, (to appear).
5. Kagan Tumer and Joydeep Ghosh, "Linear and Order Statistics Combiners for Pattern Classification," A. Sharkey, Editor, *Combining Artificial Neural Networks*, pp. 127-162, Springer-Verlag, 1999.
6. Joydeep Ghosh, Kagan Tumer, Steven Beck and Larry Deuser, "Integration of Neural Classifiers for Passive Sonar Signals," C. T. Leondes, Editor, *Control and Dynamic Systems—Advances in Theory and Applications*, Vol. 77, pp 301-338, Academic Press, 1996.

#### Refereed Conference Papers:

1. Nikunj C. Oza, Irem Y. Tumer, Kagan Tumer, and Edward Huff, "Classification of Aircraft Maneuvers for Fault Detection." Submitted.
2. David Wolpert and Kagan Tumer, "Beyond Mechanism Design," *ICM Game Theory Conference*, "Heterogeneous and Social Games" special session, Qingdao, China, August 2002. To appear.
3. Kagan Tumer, Adrian Agogino, and David Wolpert, "Learning of Sequences of Actions for Collectives of Autonomous Agents," *Proceedings of the Autonomous Agents and Multi-Agents Systems Conference*, Bologna, Italy, July 2002. To appear.
4. David Wolpert and Kagan Tumer, "Optimal Reward Functions in Distributed Reinforcement Learning," *Intelligent Agent Technology (IAT-2001)*, Maebashi City, Japan, October, 2001.
5. David Wolpert, Joseph Sill and Kagan Tumer, "Reinforcement Learning in Distributed Domains: Beyond Team Games," *Proceedings of the Seventeenth International Conference on Artificial Intelligence*, pp. 819-824, Seattle, WA, August 2001.
6. Nikunj C. Oza and Kagan Tumer "Reducing Classifier Correlation with Input Decimation," *Multiple Classifier Systems*. pp.238-247, Cambridge, UK, July 2001.
7. Kagan Tumer and David Wolpert, "Collective Intelligence and Braess' Paradox," *Seventeenth National Conference on Artificial Intelligence*, pp. 104-109, Austin, Tx, August 2000.
8. David Wolpert, Sergey Kirshner, Chris Merz and Kagan Tumer, "Adaptivity in Agent-Based Routing for Data Networks," *Fourth International Conference on Autonomous Agents*, Barcelona, Spain, pp. 396-403, June 2000.
9. Kagan Tumer and Nikunj C. Oza, "Decimated Input Ensembles for Improved Generalization" *Proceedings of the International Joint Conference on Neural Networks*, Washington, DC, July 1999.
10. David Wolpert, Kevin Wheeler and Kagan Tumer, "Automated Design of Multi-Agent Systems," *Third International Conference on Autonomous Agents*, Seattle, WA, pp. 77-83, May 1999.
11. David Wolpert, Kagan Tumer, Jeremy Frank, "Using Collective Intelligence to Route Internet Traffic," *Advances in Neural Information Processing Systems-11*, Denver CO, M. Kearns, S. A. Solla, and D. Cohn editors, pp. 952-958, December 1998.
12. Kagan Tumer, Kurt Bollacker and Joydeep Ghosh, "A Mutual Information Based Ensemble Method to Estimate Bayes Error," *Intelligent Engineering Systems through Artificial Neural Networks*, Vol. 8, pp. 17-23, November 1998.
13. Kagan Tumer and Joydeep Ghosh, "Classifier Combining through Trimmed Means and Order Statistics," *Proceedings of the International Joint Conference on Neural Networks*, Anchorage, AL, pp. 757-762, June 1998.

14. Kagan Tumer, Nirmala Ramanujam, Rebecca Richards-Kortum and Joydeep Ghosh, "Spectroscopic Detection of Cervical Pre-Cancer through Radial Basis Function Networks," *Advances in Neural Information Processing Systems-9*, Denver, CO, Mozer, M. C., Jordan, M. I., and Petsche T. editors, pp 981-987, M.I.T. Press, 1997.
15. Kagan Tumer and Joydeep Ghosh, "Estimating the Bayes Error Rate through Classifier Combining," *Proceedings of the 13th International Conference on Pattern Recognition*, Vienna, Austria, Volume II, Track B, pp. 695-699, August 1996.
16. Kagan Tumer and Joydeep Ghosh, "Limits to Performance Gains in Combined Neural Classifiers," *Artificial Neural Networks in Engineering*, St. Louis, MO, pp. 419-424, November 1995.
17. Kagan Tumer and Joydeep Ghosh, "Order Statistics Combiners for Neural Classifiers," *Proceedings of the World Congress on Neural Networks*, Washington, D.C., pp. I:31-34, INNS Press, July 1995.
18. Kagan Tumer and Joydeep Ghosh, "Boundary Variance Reduction for Improved Classification through Network Combining (Invited paper)," *Applications and Science of Artificial Neural Networks, Proceedings of the SPIE*, Orlando, FL, Vol. 2492, pp. 573-584.
19. Kagan Tumer and Joydeep Ghosh, "A Framework for Estimating Performance Improvements in Hybrid Pattern Classifiers," *Proceedings of the World Congress on Neural Networks*, San Diego, CA, pp. III:220-225, June 1994.
20. Kagan Tumer and Joydeep Ghosh, "Sequence Recognition by Input Anticipation," *The Proceedings of the Seventh International Conference on Industrial & Engineering Applications of Artificial Intelligence & Expert Systems*, Austin, TX, June 1994.
21. Joydeep Ghosh, Kagan Tumer, Steven Beck and Larry Deuser, "Integration of Local and Global Neural Classifiers for Passive Sonar Signals," *Proceedings of the International Simulation Technology Conference*, Houston, TX, pp. 539-545, November 1992.

#### **Other Conference/Workshop Papers:**

1. David Wolpert and Kagan Tumer, "Reinforcement Learning in Distributed Domains: An Inverse Game Theoretic Approach," *AAAI Spring Symposium: Game Theoretic and Decision Theoretic Agents*, Stanford, CA, March 2001.
2. Joydeep Ghosh and Kagan Tumer, "Ensemble Techniques for Data Mining in Heterogeneous Environments," *Institute for Operations Research and the Management Sciences Conference*, San Antonio, TX, November 2000.
3. David Wolpert and Kagan Tumer, "An illustration of the COIN Approach to the Design of Multi-Agent Systems," *Working notes of the Agents '00 and ECML '00 Workshop on Learning in Agents*, S. Sen and P. Stone, Editors, Barcelona, Spain, June 2000.
4. David Wolpert, Sergey Kirshner, Chris Merz and Kagan Tumer, "Adaptivity in Agent-Based Routing for Data Networks," *High Performance Computing and Communications Computational Aerosciences (HPCC/CAS) Workshop*, Moffet Field, CA, February 2000.
5. David H. Wolpert and Kagan Tumer "Collective Intelligence for Optimization," *IJCAI '99 Workshop on Statistical Machine Learning for Large-Scale Optimization*, Stockholm, Sweden, July 1999.
6. David H. Wolpert, Kagan Tumer and Ann Bell, "Collective Intelligence for Network Routing," *AAAI Workshop*, Orlando, FL, July 1999.
7. David H. Wolpert and Kagan Tumer, "Collective Intelligence," *Workshop on Economics and Heterogeneous Interactive Agents*, Genoa, Italy, May 1999.

8. Ann M. Bell, William Sethares, David Lucking-Reiley, David H. Wolpert, Kagan Tumer and Jeremy Frank, "Strategic Behavior, Learning and the Efficient Allocation of Network Resources," *International Congress on Networks, Groups and Coalitions*, Manresa, Spain, May 1999.
9. Kagan Tumer and Joydeep Ghosh, "Classifier Combining: Analytical Results and Implications," *Integrating Multiple Learned Models for Improving and Scaling Machine Learning Algorithms* workshop, *Thirteenth National Conference on Artificial Intelligence*, Portland, August 1996.
10. José Nelson Amaral, Kagan Tumer and Joydeep Ghosh, "Applying Genetic Algorithms to the State Assignment Problem: A Case Study," *SPIE proceedings on Adaptive and Learning Systems*, Vol. 1706, pp. 2-13, April 1992.
11. Kagan Tumer, David Torres, and Roland Chemali, "A New Algorithm for Automatic Shoulder Bed Correction of Dual Laterolog Tools," *Transactions of SPWLA 32nd Annual Logging Symposium*, June 1991.

**Thesis/Dissertation:**

1. Kagan Tumer, "Linear and Order Statistics Combiners for Reliable Pattern Recognition", Ph.D. Dissertation, The University of Texas at Austin, Dept. of Electrical and Computer Engineering, May 1996.
2. Kagan Tumer, "Structural Adaptation and Generalization in Neural Networks" Master's Thesis, The University of Texas at Austin, Dept. of Electrical and Computer Engineering August, 1992.

Some of these documents are available at URL: <http://ic.arc.nasa.gov/~kagan/tumer-pubs.html>